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National Airspace System

Air-Ground Communications
Operational Concept
NAS–SR–1361

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16. Abstract

A requirement for the National Airspace System (NAS) is to provide for air-ground communications, as identified in the NAS System Requirement Specification, NAS-SR-1000. This document presents a concept of operations for air-ground communications. It describes air-ground communications capabilities and shows the relationships between subsystems, facilities, information, and operators/users. It is intended to provide a common perspective for personnel involved in air-ground communication activities, assist in determining whether air-ground communications meet formal requirements, and support coordination among the organizations involved.

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1.0 INTRODUCTION

1.1 Background

The transfer of flight information between aircraft and ground facilities (air-ground) such as flight plans, flight movement, weather, surveillance, monitoring and control information is essential for safe and efficient operation of the NAS. This information is passed using both voice and data communication capability. Additionally, the communication system utilized must be provided continuously and reliably, and must also provide voice privacy when required.

1.2 Objective

The objective of this Operational Concept, which is based upon the National Airspace System System Requirements Specification (NASSRS) is to describe how air-ground communications will be utilized in the "end state" National Airspace System (NAS). This document is intended as a descriptive document to provide management and technical personnel of the FAA, as well as outside organizations, with a clear understanding of how air-ground communications are provided. More specifically, the purpose of this document is to:

1. Provide a common operational perspective across subsystems, operators, and users.

2. Show the interrelationship between subsystems, facilities, information, and operators/users.

1.3 Scope

This Operational Concept describes the air-ground communications services provided as outlined in Section 3.6.1 of the NASSRS. The operations described are limited to those associated solely with air-ground communications. The specific paragraphs in the NASSRS Section 3.6.1 are as follows:

3.6.1 AIR-GROUND COMMUNICATIONS

3.6.1.A Air-Ground Communications within NAS Jurisdiction
3.6.1.B Protection from Interference
3.6.1.C Storage and Retrieval of Air-Ground Communications
3.6.1.D Operating Position Monitoring
3.6.1.E Air-Ground Communications Available Continuously
3.6.1.F Reconfiguration of Air-Ground Communications

1.4 Methodology

The methodology employed to develop this operational concept is similar to the methods and tools used for system development in that successive levels of decomposition of the communications functions are represented. This document starts with the overall concept and proceeds

to its most elemental levels of support, diagrammatic tools, and techniques that constitute air-ground communications support. These analytical tools are:

1. **Operational Block Diagram/Description.** The operational block diagram illustrates the connectivity between major elements of the NAS, i.e., processors, specialists/controllers, and the user for those elements that support the service. The operational block diagram in this Operational Concept is extracted from the overall NAS Operational Block Diagram. Principal features of the operational block diagram/description include the following:

   a. Each specialist/controller is indicated by a number. This number remains the same in every operational concept.

   b. Dotted lines segregate facilities.

   c. Solid lines show digital data flow. Voice data flow in not shown.

   d. The blocks within each facility are the major processors.

2. **Operational Flow Diagrams/Descriptions.** An operational flow diagram and associated description for each specialist provides detail about the inputs, processes, outputs, and interfaces for each operator; thus, the operational flow diagram provides an expansion of each element of the NAS shown in the air-ground communications master block diagram. Operational flow diagrams are used to functionally describe the products and services of individual specialists.

3. **Operational Sequence Diagrams/Descriptions.** The operational sequence diagram and associated description show a typical sequence of steps taken by operators/users in supporting air-ground communication operations. Principal features of an operation sequence diagram include the following:

   a. Users, specialists, and computer systems involved with providing air-ground communication functions are listed along the vertical axis. When required for clarity, other FAA facilities may also be listed on the vertical axis.

   b. The horizontal axis represents time. Sequential events or functions performed are indicated within separate boxes. Events which may occur simultaneously or near-simultaneously are shown vertically.

   c. Decision points or points where alternate paths may be followed are indicated by a diamond shape.

d. Circles are connectors and indicate exit to, or entry from, another diagram. Circles with a lower case alphabetic character reference an operator function described in the figure listed below the circle. Circles connect either to another sheet of the same diagram or to another diagram; the relevant figure number is listed underneath if connection is to a different diagram. Thus, the relationship between operator/user interactions and relevant NAS subsystems can be depicted.

1.5 Document Organization

The remainder of this document is organized in the following manner. Section 2 is the main body of the document and is divided into six subsections. Section 2.1 provides an overview description of the air-ground communications function and introduces (identifies) the personnel compliment and physical entities (facilities and computer systems) which provide the required support. Section 2.2 describes the information used to provide air-ground communications support. Section 2.3 provides descriptions of the functional decomposition of air-ground communications services. Sections 2.1, 2.2, and 2.3 reference related NASSRS 3.6.1 subsystems. Section 2.4 presents the correlation requirements and Section 2.5 provides a sequence of interactions between system and personnel entities during the planning and the implementational phases of air-ground communications services. Section 2.6 describes air-ground communications operational scenarios.

2.0 AIR-GROUND COMMUNICATIONS OPERATIONS

2.1 Support

In order to provide essential services to its users the NAS must ensure it has air-ground communications. This requirement is described in Section 3.6.1 of the NASSRS. Air-ground communications are utilized by Automated Flight Service Station (AFSS) specialists, En Route and Approach/Departure Controllers at an Area Control Facility (ACF), or Tower Controllers at an Airport Traffic Control Tower (ATCT) to pass information back and forth to pilots.

Air-ground communications must be clearly intelligible and free from interference to ensure uninterrupted communications between pilots and air traffic specialists. There must be no interference from the same or adjacent facilities. The NAS shall provide these air-ground communications between pilots and air traffic specialists on a continuous basis. Air-ground communications must provide for reception at appropriate altitudes so users may contact the necessary ATC facility (AFSS, ACF, ATCT) to receive their services.

Figure 2-1 is an overview of NAS/user interfaces for air-ground communications and illustrates the NAS facilities and systems involved.

Figure 2-2 is an operational block diagram showing the interrelationships between equipment, facilities, operators/users and the information necessary to support air-ground communications. The following paragraphs briefly summarize operations at each type of facility shown in Figure 2-2.

Position(s) 3 through 5, 20,: AFSS Specialists
Functions: Inflight Briefing, En route Flight Advisory Service, Direction Finding, and Broadcast.
Description: Air traffic specialists that provide pilot weather briefings, en route communications, VFR search and rescue services, ATC clearances relay, broadcast aviation weather, assist lost/emergency aircraft, and receive and process IFR and VFR flight plans.

Procedures: FAA, Flight Service Station Procedures (FAA Handbook 7110.10I): Chapter 2, Section 1 - 4; Chapter 4, Section 1, 2, 4, 5, 7 - 9; Chapter 5, Section 1 - 4; Chapter 9, Section 2

Projects: NAS Plan, Chapter III, Flight Service and Weather Systems -Automation: Project 1, Flight Service Automation System (FSAS); Project 5, Aeronautical Data Link; - Mass Weather Dissemination: Project 7, High-Altitude En Route Advisory Service (EFAS) Frequencies; Project 8 Hazardous In-Flight Weather Advisory Service (HIWAS); - Communications: Project 13, Integrated Communications Switching System; Chapter IV, Ground-

FIGURE 2-1
OVERVIEW OF NAS/USER INTERFACES
FOR AIR-GROUND COMMUNICATIONS
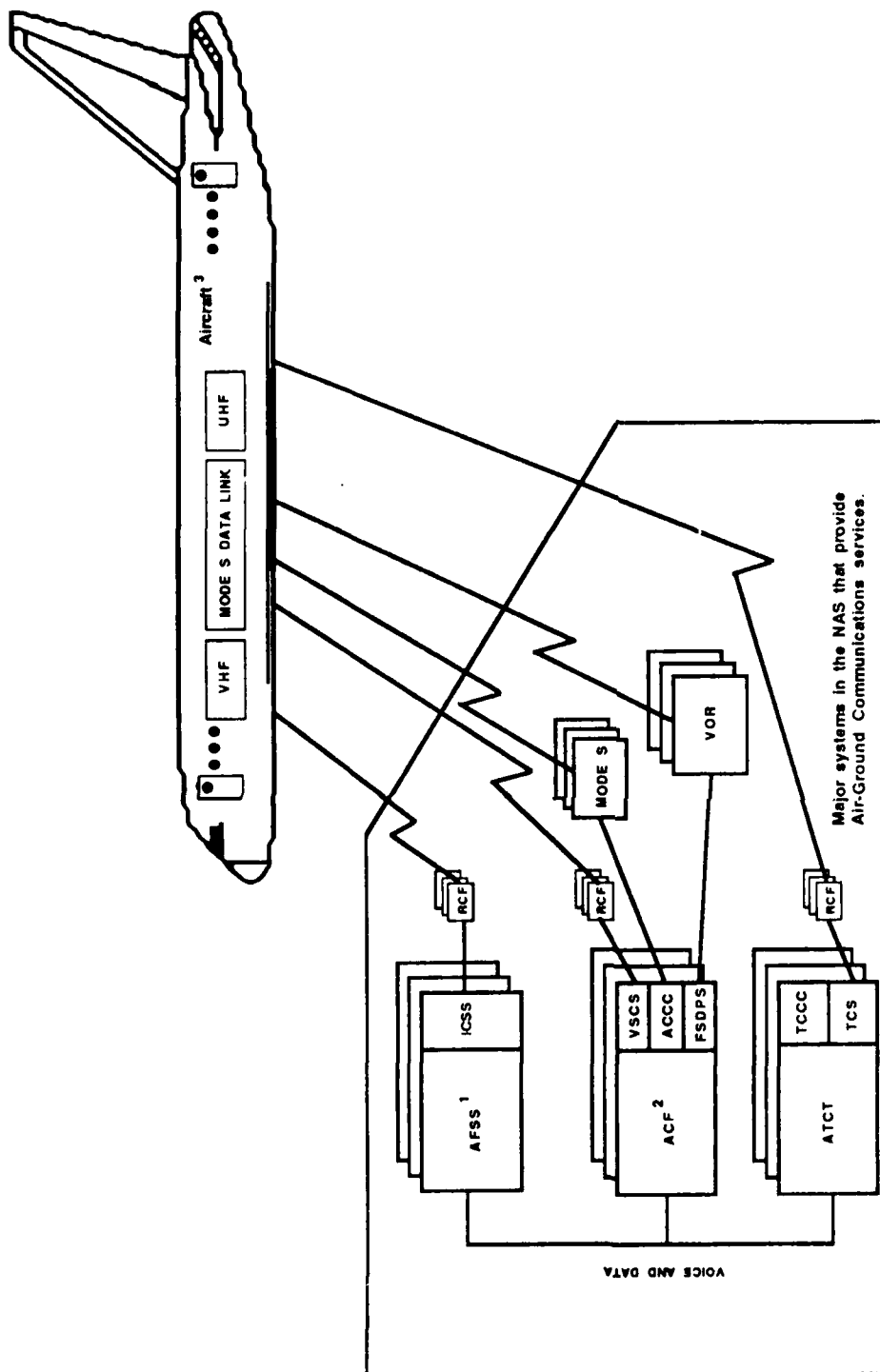
1 Primarily handles VFR aircraft.

2 Primarily handles IFR aircraft.

3 The 1995 aircraft have different combinations of these systems. As a minimum, A/G communication and surveillance enhancements are assumed.

2-2
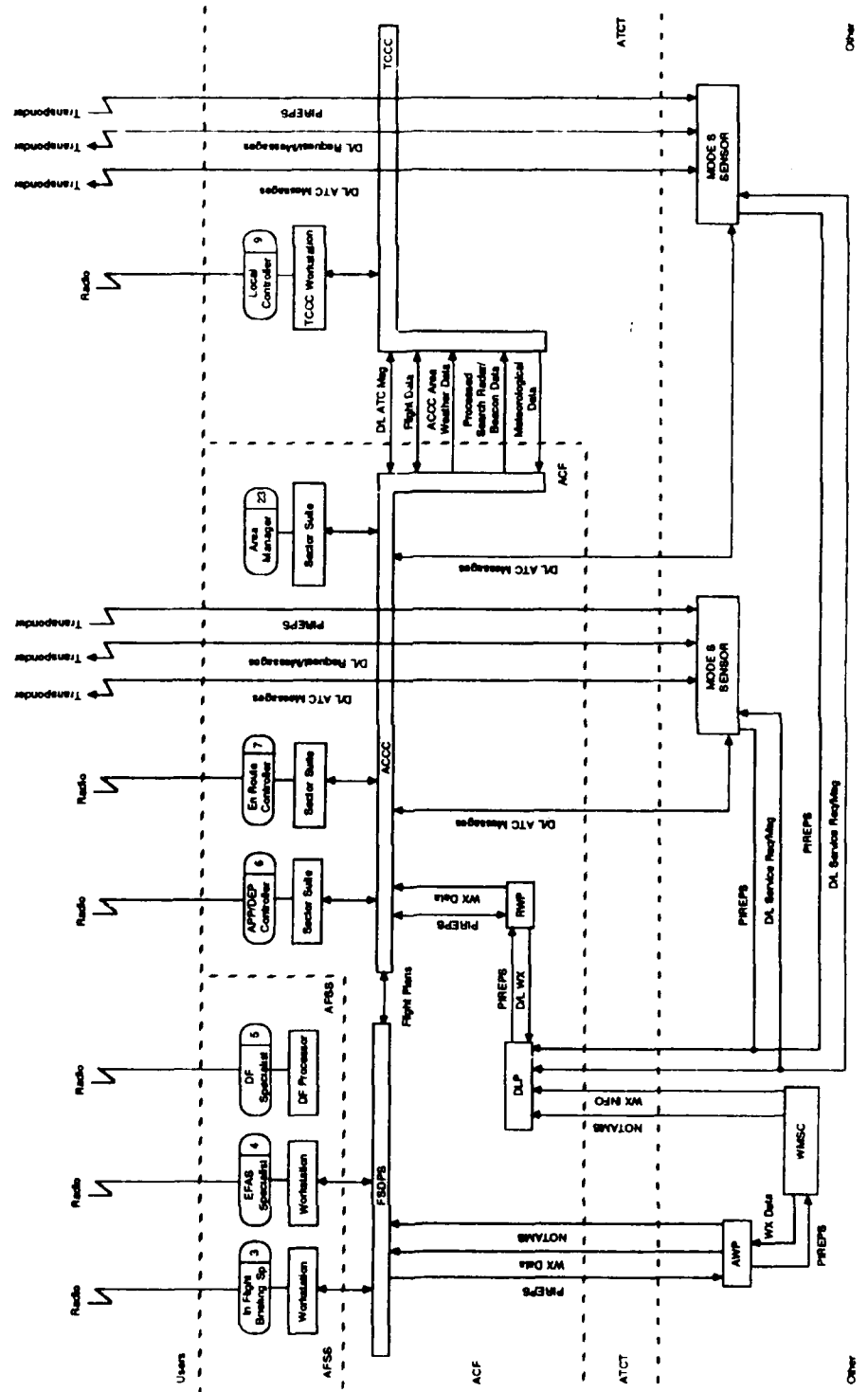
FIGURE 2-2
AIR-GROUND COMMUNICATIONS
OPERATIONAL BLOCK DIAGRAM

to-Air Systems; Project 2, Communications Facilities Consolidation/Network. Chapter V, Interfacility Communications Systems: Project 8, Radio Control Equipment (RCE). Chapter VII, Other Capital Needs: Project 20, High-Altitude En Route Flight Advisory Service (EFAS) Expansion; Project 3^ Air/Ground Radio Frequency Interference (RFI) Eliminaىion.

Position(s) 6, 7, 22 and 23: ACF Specialists
Function: Approach/Departure, Radar En Route, Non-Radar En Route Control, and Area Managers.
Description: These specialists provide traffic and weather advisories and separation of air traffic through the Area Control Facility airspace in both the terminal and en route environments. Area Supervisors/ Managers provide overall management of ACF ATC operations.

Procedures: FAA, Air Traffic Control (FAA Handbook 7110.65F); Chapter 2, Section 1, 2, 4, 6, 9; Chapter 4, Section 2 - 8; Chapter 5, Section 2, 4; Chapter 7, Section 6 & 7; Chapter 9, Sections 2, 3, 4

Projects: NAS Plan, Chapter III, En Route Systems: Project 11, Voice Switching and Control System (VSCS); Project 15, Area Control Facilities (ACF); Flight Service and Weather Systems - Automation: Project 5, Aeronautical Data Link; Chapter IV, Ground-to-Air Systems: Project 2, Communications Facilities Consolidation/Network; Project 12, Mode S; Chapter V, Interfacility Communications Systems - Project 8, Radio Control Equipment (RCE); Chapter VII, Other Capital Needs: Project 30, Air/Ground Communications Radio Frequency Interference (RFI) Elimination; Project 80, Area Control Facilities Data Link Services.

Position(s) 9 through 11: ATCT Controllers
Function: Local Control, Ground Control, and Clearance Delivery Control.
Description: Air traffic specialists that control air traffic on the airport surface, within the Airport Traffic Area (ATA) and surrounding airport areas.

Procedures: FAA, Air Traffic Control (FAA Handbook 7110.65F): Chapter 2, Sections 1, 2, 4, 6, 9,; Chapter 3, Section 1, 10; Chapter 7, Section 6 & 7; Chapter 9, Section 2 & 3.

Projects: NAS Plan, Chapter III, Terminal Systems - Communications: Project 10, Automatic Terminal Information Service (ATIS) Recorders; Project 11, Multichannel Voice Recorders; Project 12, Tower

Communications System (TCS); Chapter V, Project 8, Radio Control Equipment (RCE); Chapter VII, Other Capital Needs: Project 30, Air/Ground Communications Radio Frequency Interference (RFI) Elimination.

2.2 Information

The NAS is capable of transferring information between aircraft and NAS ground facilities via air-ground voice and data communications within the en route and terminal airspace of the conterminous United States, Alaska, Hawaii, and Puerto Rico. The following paragraphs describe these requirements for air-ground communications.

2.2.1 Information About Air-Ground Communications

Air-ground communications within the NAS consists of equipment that enables air traffic specialists to communicate with pilots. Information passed between pilots and controllers is communicated via voice using Very High Frequency (VHF) and Ultra High Frequency (UHF) radios and data link for both civilian and military users. The following paragraphs describe voice communications within the NAS.

Air-ground communications such as radio transmissions are provided by Remote Communications Facilities (RCFs). The RCFs provide the voice and data communications links between pilots, air traffic specialists, and processors. These RCFs provide two-way voice communication links and some broadcast links supplied to specific VHF omnidirectional range facilities (VORs). The communications links are provided between groundbased personnel (air traffic specialists in AFSSs, ACFs, and ATCTs) and pilots in the air or on the ground. This is accomplished by the use of ground based UHF and VHF radio transmitters and receivers transmitting on frequency ranges of 117.975 to 136.000MHz and 225 to 400MHz respectively.

The next major component of air-ground communications is the VHF/UHF communications outlet. These outlets consist of radio transmitters, receivers, and antennas in a RCF. The outlet is used to provide a channel through which ground-based specialists can verbally communicate with pilots and other vehicle operators operating on airfields where there is an operating ATCT. When the specialist transmits, the communications outlet will use the analog voice signal it receives to modulate a carrier which then can be transmitted to the pilot. The outlet receives the reply by demodulating the radio signal received from the aircraft and sends the resulting analog voice signal to the intended specialist via the NAS Interfacility Communications System (NICS).

The NICS provides the voice and data communications interconnectivity between facilities and sites within the NAS. The transmission function of the NICS provides the connectivity to the distributed facilities and equipment of the NAS. The switching functions of the NICS adds the operational flexibility needed to reconfigure resources (combine sectors) or reroute service in the event

of equipment failure. The NICS Radio Control Equipment (RCE) supports ground-to-air voice communications and connectivity between the voice switching equipment in the operational ATC facilities (e.g., AFSS, ACF, ATCT) and the ground-to-air radio equipment in the remote communications facilities.

The second type of air-ground communications link is a one-way communications link between ground based processors and aircraft. This is accomplished by use of ground-based VHF and UHF radio transmitters, but no receivers. By means of this link, weather information and Automatic Terminal Information Service (ATIS) messages are passed to pilots over the navigational aids they are using.

The other major communication system used in the NAS to pass aeronautical information is through data link. Aeronautical data link provides the capability to send and receive messages to and from suitably equipped aircraft. The Mode S sensor is a combined beacon interrogator and ground-air-ground data link system which is part of the surveillance facilities. This sensor provides a means for automated data communications between the aircraft and the various ground-based processors. The Mode S sensor exchanges data link messages with the ACCC in the ACF in digital format via the NICS. The ACCC then passes the message to the TCCC, if requested by the Tower Controller, which relays it to the requesting specialist. Through this data link arrangement, the pilot has an automated communications link with the various controllers and specialists in the system to supplement voice communications.

The Mode S sensor processor assists the ACCC in providing appropriate routing of data link messages to and from aircraft that cross over the coverage boundary between sensors. Data link ATC messages, including messages originated from ground processors and controllers, without a request, are handled exclusively by the ACCC. Data link ATC messages destined for the ATCT are passed from the ACCC to the TCCC, which in turn, forwards the message to the ATCT controller. Messages from ATCT controllers, to be transmitted to aircraft under their control via data link, are forwarded through the TCCC to the ACCC.

For weather information and products the Mode S sensor sends PIREPs and data link service requests to the Data Link Processor (DLP) located in the ACF. The DLP also sends weather information to the Mode S sensor for relay to suitably equipped aircraft. Through this data link arrangement, the pilot has access to specific weather and aeronautical information stored at the DLP. The Mode S sensor also sends sensor/aircraft changes to the DLP when an aircraft enters or leaves its area of coverage.

When a data link service request for current weather, NOTAMs, PIREPs, hazardous weather, or other available data is received, the DLP the message, compiles the necessary data from its data base and encodes the appropriate data link service message. The encoded data link service message is returned to the requesting aircraft via the

appropriate Mode S sensor. PIREPs, which require no reply, are received by the DLP from the Mode S data link and forwarded for use and distribution.

An example of an ATC data link message in the terminal area would be ATIS. Pilots approaching a terminal area would request ATIS information via data link early enough to plan their approach. The data link request for ATIS would be sent to the ACCC via the Mode S data link. The ACCC would contain a data base of current ATIS messages for all terminals in its area. The ATIS messages are provided to the ACCC by the TCCC's serving the airports in the ACF area. The ACCC would respond to the pilot request with the ATIS information for the requested terminal, which would be data linked to the aircraft through the Mode S sensor.

2.2.2 Storage and Retrieval

The NAS is able to receive, store, and readily retrieve all NAS air-ground communications, both voice and data. Air-ground voice communications are stored on multichannel voice recorders. These recorders allow NAS specialists to retrieve communications from both on-line and off-line storage in the event they need to playback voice communications.

Individual air-ground data messages are also capable of being retrieved from off-line storage for review. This information can be retrieved at a later date for replay if needed.

2.2.3 Position Monitoring

The NAS also has the capability to monitor any operating position without introducing any change in transmission or reception characteristics. This allows NAS personnel to monitor a position (e.g. emergency situations) without interfering with the specialist. In this situation a manager can monitor conversations between a specialist and a pilot or other specialists to obtain information and provide assistance if needed.

2.2.4 Reconfiguration

In the event of a planned or unplanned reconfiguration within a facility, the NAS shall have the capability to reconfigure these communications systems to support changes or consolidation in operating position responsibilities. The NAS is capable of reconfiguring specialists' positions, including their communications capability, to support these position changes. This enables specialists to combine positions up at night or during off-peak hours.

Specialists in adjacent ACF facilities shall have air-ground voice and data communications capability in the event of the adjacent ACF failure. This enables specialists in adjacent ACFs to reconfigure communications to allow access to the RCF facilities of the ACF that had

a catastrophic failure thereby enabling them to continue working the affected air traffic.

2.3 Functions

The following paragraphs describe in more detail the functions provided by the specialist/controller positions introduced in Section 2.1. The Operational Flow Diagrams associated with each paragraph illustrate the information flow between the specialist within their respective facility and the user, and between the specialist and data processing equipment. The functions performed by the NAS are explicitly covered by requirements specified in the NASSRS. The pertinent NASSRS paragraphs that specify the function being performed by the NAS are referenced in each of the paragraphs that follow. As used in this paragraph, the term "specialist" also includes controllers.

2.3.1 AFSS Specialists (Positions 2 through 5, 20, 21)

The AFSS Specialists provide flight service functions to pilots through the Integrated Communications Switching System (ICSS). In addition to the ICSS, AFSS personnel have direct voice interface with VOR equipment to provide emergency voice transmission to pilots. The operation of the VOR equipment is available through the Flight Service Data Processing System (FSDPS) data interface with the AFSS work station. This communication capability is available continuously to specialists and can be reconfigured to the specialist's operational needs.

Figure 2-3 is an operational flow diagram describing the functions and services provided by the specialists at the AFSS. Functions performed by the equipment and these specialists are lettered within each block and are described in the corresponding paragraphs below.

a. **FSDPS Processing.** The FSDPS supports the AFSS work station which is combined in various configurations to support the different AFSS operational positions. Direct voice interface in the form of emergency messages are transmitted over the VOR in the same manner as the facility voice identification.

   NASSRS Requirement 3.6.1.A

b. **Integrated Communications Switching System (ICSS).** The AFSS voice communications with pilots will be primarily supported via radio contact through ICSS interface with the ground-to-air communications facilities or by telephone. The ICSS provides for the independent operation of each frequency (VHF/UHF) of the ground-air communications between AFSS specialists and pilots. The ICSS also provides supervisory personnel the ability to monitor any operating position within the AFSS without distracting the specialist.

   NASSRS Requirement 3.6.1.A, B, D, E, F

USER

NAS
Communications
Facilities

Radio Comm

RCF VHF/UHF
Comm Outlet

AFSS

Phone Comm

NICS

Voice Comm

b. ICSS

c. MVR

ACF

POSITIONS 2-5, 20, 21:
AFSS SPECIALISTS
AIR-GROUND COMMUNICATIONS

d. Performs AFSS Functions Using
Air-Ground Communications.

Flight Plan

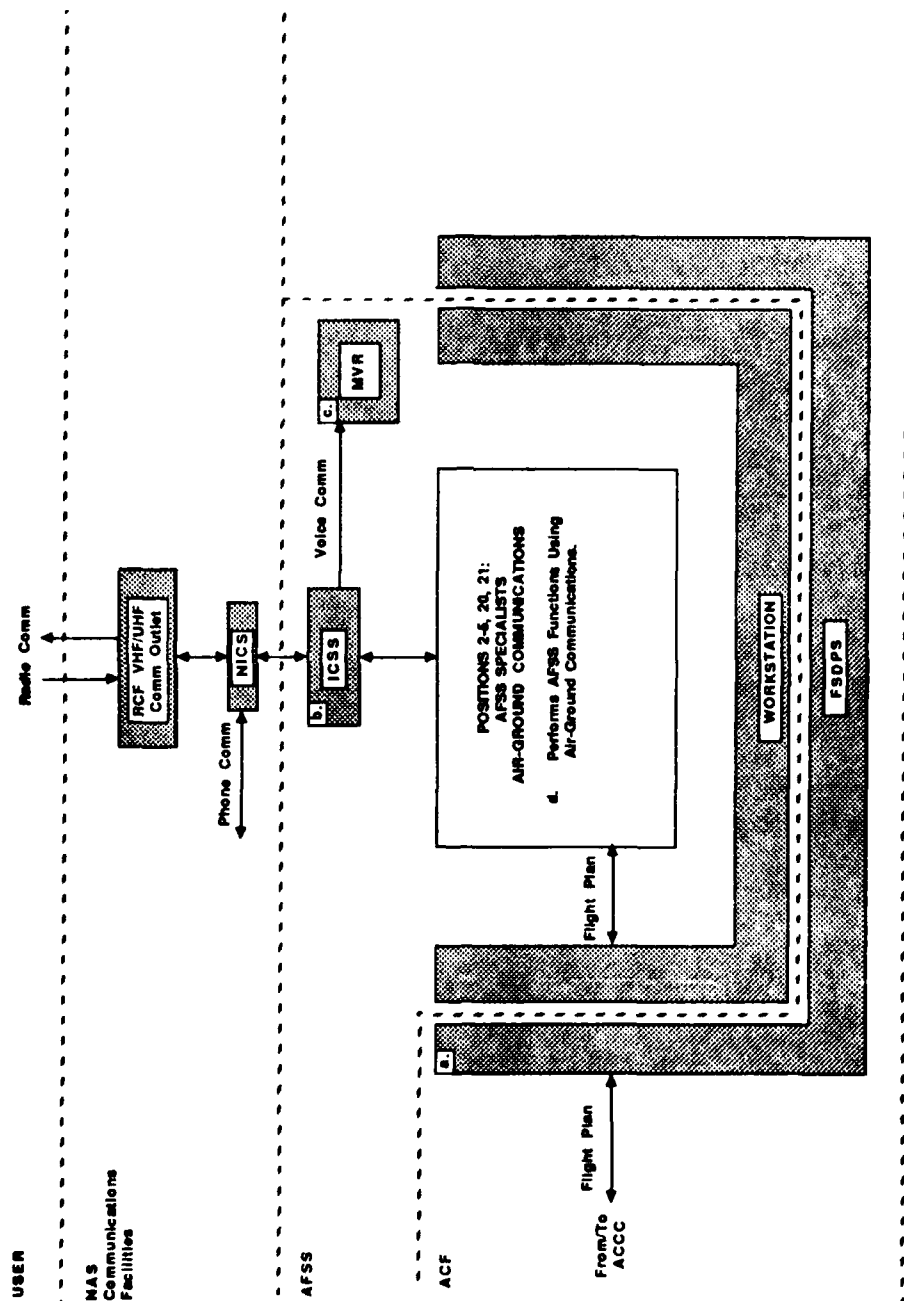WORKSTATION

FSDPS

a.

Flight Plan

From/To
ACCC

FIGURE 2-3
POSITIONS 2-5, 20, 21: AFSS SPECIALISTS
OPERATIONAL FLOW DIAGRAM
FOR AIR-GROUND COMMUNICATIONS

c. **Multichannel Voice Recorders.** Multichannel voice recorders are utilized to record all voice communications between air traffic specialists and pilots. The ICSS provides the communications interface required to record messages that require recording.

NASSRS Requirement 3.6.1.C

d. **Perform AFSS Services Using Air-Ground Communications.** AFSS specialists utilize the FSDPS and the ICSS to perform air-ground communication with users.

NASSRS Requirement 3.6.1.A

2.3.2 ACF Specialists (Positions 6 through 8, 22, 23)

The ACF specialists transmit and receive flight information to pilots through the Voice Switching and Control System (VSCS). The VSCS is interfaced with the Area Control Computer Complex (ACCC) in the ACF, which provides configuration and status information. ATC messages are sent via data link from the controllers position console, through the ACCC to the Mode S sensor to the Mode S transponder and data link avionics aboard the aircraft.

Figure 2-4 is an operational flow diagram describing the functions and services provided by specialists at the ACF. Functions performed by the equipment and these specialists are lettered within each block and are described in the corresponding paragraphs below.

a. **Area Control Computer Complex (ACCC) Processing.** The ACCC provides the ATC supervisor the status and control of VSCS reconfiguration to include predetermined configuration maps stored in the VSCS data base, temporary on-line modification of position-level (console) configuration maps, and assignment capability of multiple positions to one position. In addition the ACCC provides the ATC supervisor the status of VSCS maps, status of air-ground and ground-ground resources connected to the ACCC, status of VSCS position (console) equipment, and VSCS reconfiguration status reports. The ACCC provides the assignment of individual Common Consoles to Sector Suites and the designation of a Sector Suite as a particular type of operational position so that reassignments for reconfiguration (e.g., scheduled changes for day/night operation or shifts or equipment failure) may be done in a routine manner.
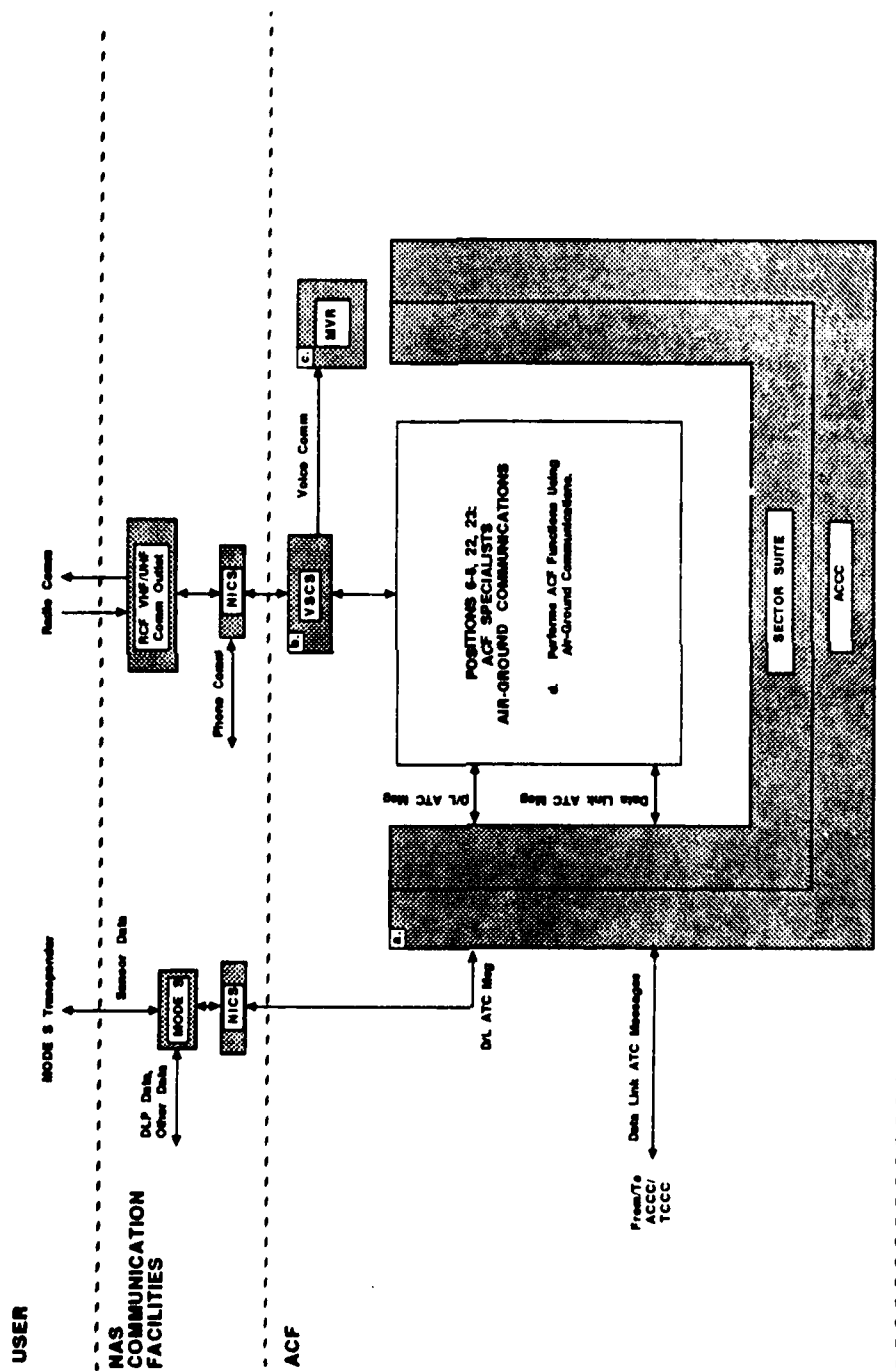
NASSRS Requirement 3.6.1.A

FIGURE 2-4
POSITIONS 6-8, 22, 23: ACF SPECIALISTS
OPERATIONAL FLOW DIAGRAM
FOR AIR-GROUND COMMUNICATIONS

b. **Voice Switching and Control System (VSCS).** The VSCS provides a local voice switching node to connect ACF operational positions (controller work stations) to VHF/UHF transmitters and receivers or transceivers. The VSCS operates in conjunction with the radio control equipment (RCE) and the VHF/UHF communications outlet to continuously provide two way communications capability between the pilot and controller. The VSCS also provides supervisory personnel the ability to monitor any operating position within the ACF without distracting the specialist.

NASSRS Requirement 3.6.1.A, B, D, E, F

c. **Multichannel Voice Recorders.** Multichannel voice recorders are utilized to record all voice communications between air traffic specialists and pilots. The communications interface required to record voice messages is provided by the VSCS.

NASSRS Requirement 3.6.1.C

d. **Perform ACF Functions Using Air-Ground Communications.** ACF specialists utilize the ACCC and the VSCS to perform air-ground communications with users.

NASSRS Requirement 3.6.1.A

2.3.3 ATCT Specialists (Positions 9 through 11)

ATCT controllers separate traffic on the ground and in the air around airports. In order to perform these functions they must communicate with pilots and ground personnel through the Tower Communication System (TCS).

Figure 2-5 is an operational flow diagram describing the functions and services provided by specialists in the ATCT. Functions performed by the equipment and these specialists are lettered within each block and are described in the corresponding paragraphs below.

a. **Area Control Computer Complex (ACCC) Processing.** The ACCC provides data link ATC message service to the Tower Control Computer Complex (TCCC) for send and receive transmission between aircraft and ATCT controllers.

NASSRS Requirement 3.6.1.A

b. **Tower Control Computer Complex (TCCC).** The TCCC provides the ability to combine or reconfigure operational control positions from one physical location in the facility to another, based on the runways in use, traffic load, weather conditions, or other considerations. The interface between the TCCC and the TCS consists of the output of ATIS data (analog voice) from the TCCC to the TCS. The TCS sends the ATIS data through the
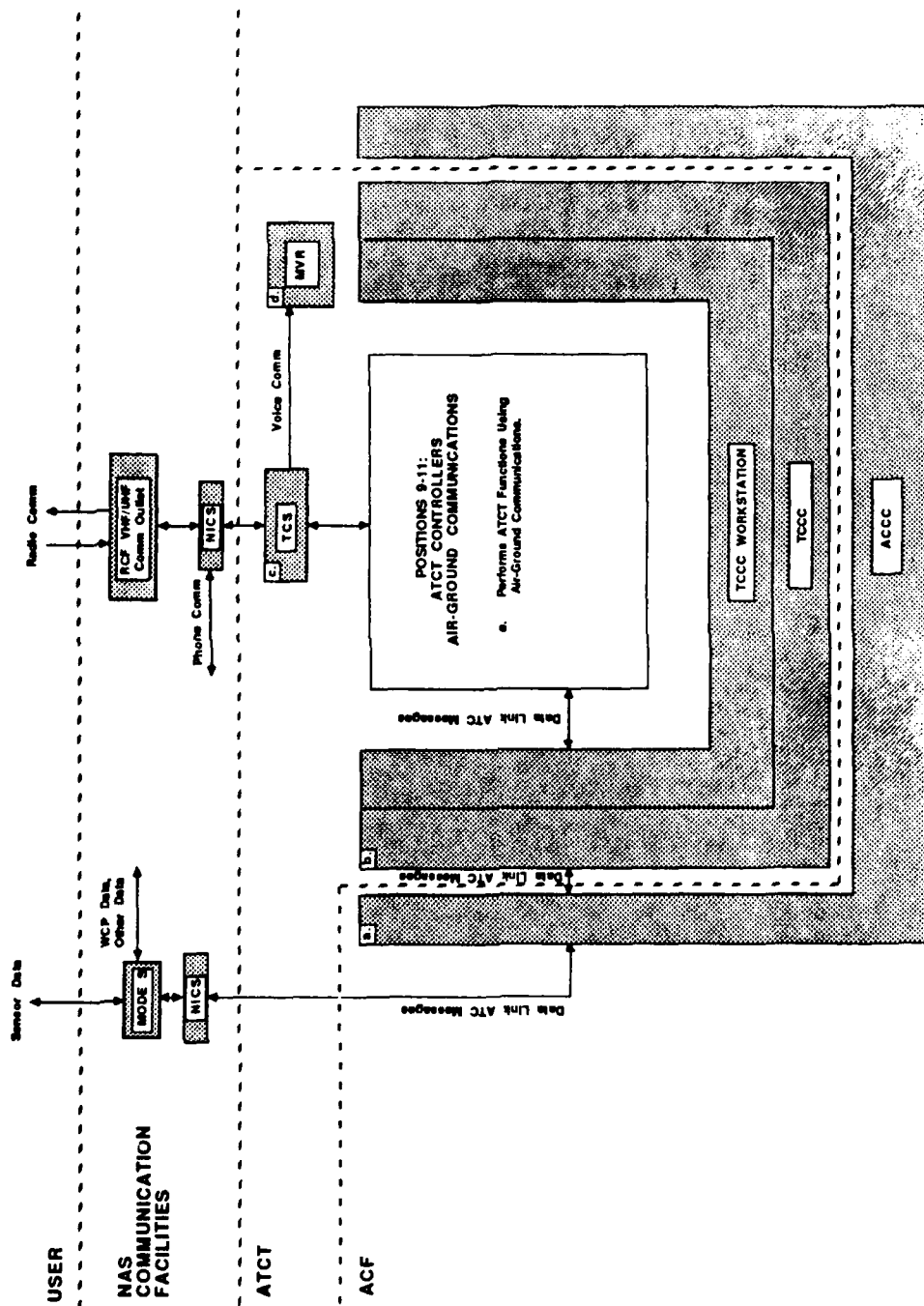
FIGURE 2-5
POSITIONS 9-11: ATCT CONTROLLERS
OPERATIONAL FLOW DIAGRAM
FOR AIR-GROUND COMMUNICATIONS

local communications outlet for broadcasting. In addition, the TCCC controls the communications configuration in the ATCT by receiving configuration status messages from, and providing configuration control messages to, the TCS.

NASSRS Requirement 3.6.1.A

c. **Tower Communications System (TCS)**. The TCS provides voice communications connectivity to the VHF/UHF communications outlets for the exchange of air traffic control information between controllers and pilots. The TCS also provides supervisory personnel the ability to monitor any operating position within the ATCT without distracting the specialist.

NASSRS Requirement 3.6.1.A, B, D, E, F

d. **Multichannel Voice Recorders**. Multichannel voice recorders are utilized to record all voice communications between air traffic specialists in ATCTs and pilots. The TCS provides the communications interface between the TCS and the voice recorder for messages that require recording.

NASSRS Requirement 3.6.1.C

e. **Perform ATCT Functions Using Air-Ground Communications**. ATCT specialists utilize the TCCC and TCS to perform air-ground communications with users.

NASSRS Requirement 3.6.1.A

2.4 Correlation with Operational Requirements

Table 2-1 summarizes the correlation of the air-ground communications operational requirements graphs of NAS-SR-1000 with the paragraphs describing the functions being performed by specialists/ controllers. All air-ground communications paragraph numbers of NAS-SR-1000 are listed; paragraphs which are introductory in nature, do not state an explicit operational requirement, or which reference other portions of NAS-SR-1000 are indicated with a dash. The fact that a correlation is shown between a requirements paragraph and a paragraph describing the specialist/controller functions performed should not be construed as indicating that the requirement is completely fulfilled.

2.5 Operational Sequence

Operational sequence diagrams have been developed to illustrate the interactions between users (pilots) and specialists/controllers for different categories/conditions of flight. These diagrams are general in nature and are not intended to depict a unique or specific situation.

TABLE 2-1
AIR-GROUND COMMUNICATIONS
OPERATIONAL REQUIREMENTS CORRELATION

NAS FACILITIES / NAS-SR-1000 PARAGRAPH	AFSS SPECIALISTS				ACF SPECIALISTS				ATCT SPECIALISTS				
	2.3.1.a	2.3.1.b	2.3.1.c	2.3.1.d	2.3.2.a	2.3.2.b	2.3.2.c	2.3.2.d	2.3.3.a	2.3.3.b	2.3.3.c	2.3.3.d	2.3.3.e
3.6.1 General	—	—	—	—	—	—	—	—	—	—	—	—	—
3.6.1.A Air To Ground Comms Within NAS	×	×			×	×			×	×	×		
3.6.1.B Protection From Interference		×		×		×		×			×		×
3.6.1.C Storage And Retrieval Of Comms			×				×					×	
3.6.1.D Operating Position Monitoring		×				×					×		
3.6.1.E Air To Ground Comms Available		×				×					×		
3.6.1.F Reconfiguration Of Air To Ground	×				×						×		

2.5.1 AFSS Air-Ground Communications Sequence (Voice)

Figure 2-6 illustrates a general sequence of operator/user interactions between pilots and AFSS specialists. In this sequence an En route Flight Advisory Service (EFAS) specialist receives a call on his VHF radio from a pilot requesting inflight weather conditions along his route of flight (1). The EFAS specialist queues up the weather conditions for the requested route of flight (2) from the FSDPS (3). The EFAS specialist then transmits the weather data to the pilot via radio (4). Once the pilot receives the weather briefing via radio (5) and no longer needs the inflight service he notifies the specialist (6). The EFAS Specialist acknowledges the pilots intentions (7).

2.5.2 ACF Air-Ground Communications Sequence (Mode S Data Link/Voice)

Approach/Departure and En route Controllers working in the ACF use the VSCS to communicate with pilots for voice and through the Mode S sensor for data link. The following sequences are reflective of both types of controllers and therefore appear together as ACF controllers.

Figure 2-7 portrays the air-ground communication that takes place when a pilot establishes contact with a controller upon entering his sector from an adjacent sector and the on-going communication within the sector. The pilot makes initial contact via voice channel to alert the controller that he is on the proper frequency (1). The ACF controller acknowledges (2). The pilot, encountering turbulence, contacts the controller via voice and immediately requests a descent from the controller (3). The ACF controller acknowledges the descent request (4) and checks the traffic situation in the sector (5) to determine if a lower altitude is available from the ACCC. When a lower altitude is available (6) the ACF controller issues the descent clearance to the pilot (7). The pilot acknowledges the clearance to descend to the new altitude (8) and the ACF controller receives the descent acknowledgement (9). The pilot decends and once level at the new altitude, the pilot alerts the ACF controller via data link (10). The ACF controller observes the data block change that the aircraft is level at the new altitude (11). When the pilot approaches the boundary of the sector, and the ACF controller has completed the handoff to the next sector, the controller advises the pilot via data link to contact the next controller on a designated frequency (12). The pilot acknowledges the data link message (13) which results in both data link and voice communications control being transferred to the next controller.

2.5.3 ACF Air-Ground Communication Sequence (Monitoring)

Figure 2-8 shows the sequence of events that takes place when NAS personnel, in this case an Area Manager, needs to monitor a position without distracting the controller. In this sequence the Area Manager monitors the controller handling an in-flight emergency in order to determine the need for ourside assistance. The pilot advises the controller that he is having a problem and declares an emergency (1).
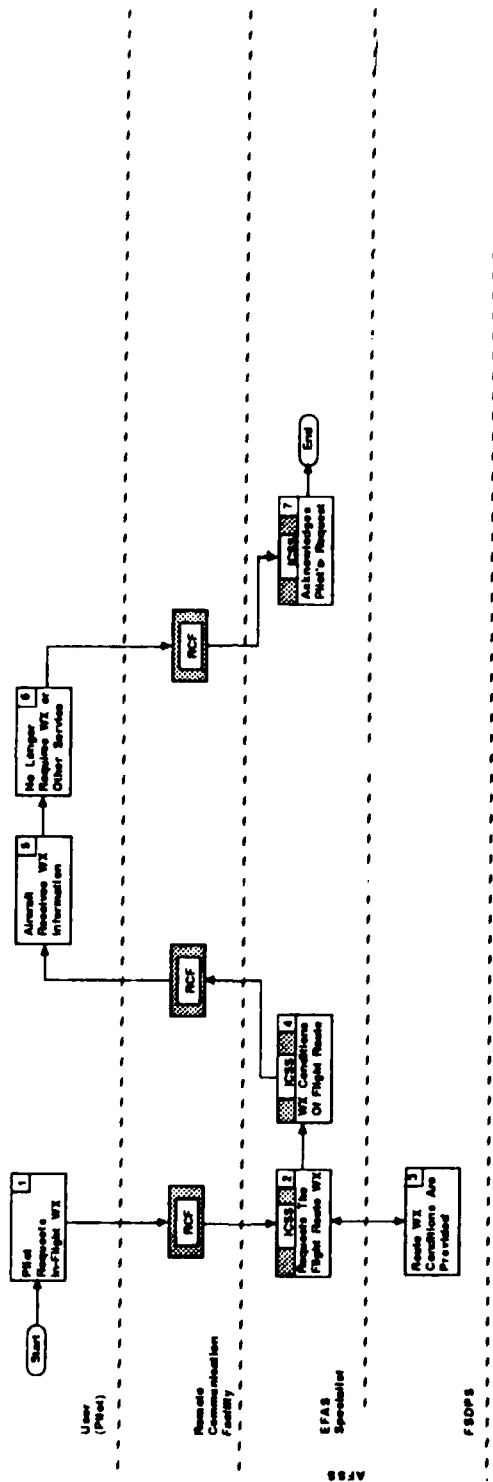
2-16

FIGURE 2-6
AFSS
AIR-GROUND COMMUNICATIONS (VOICE)
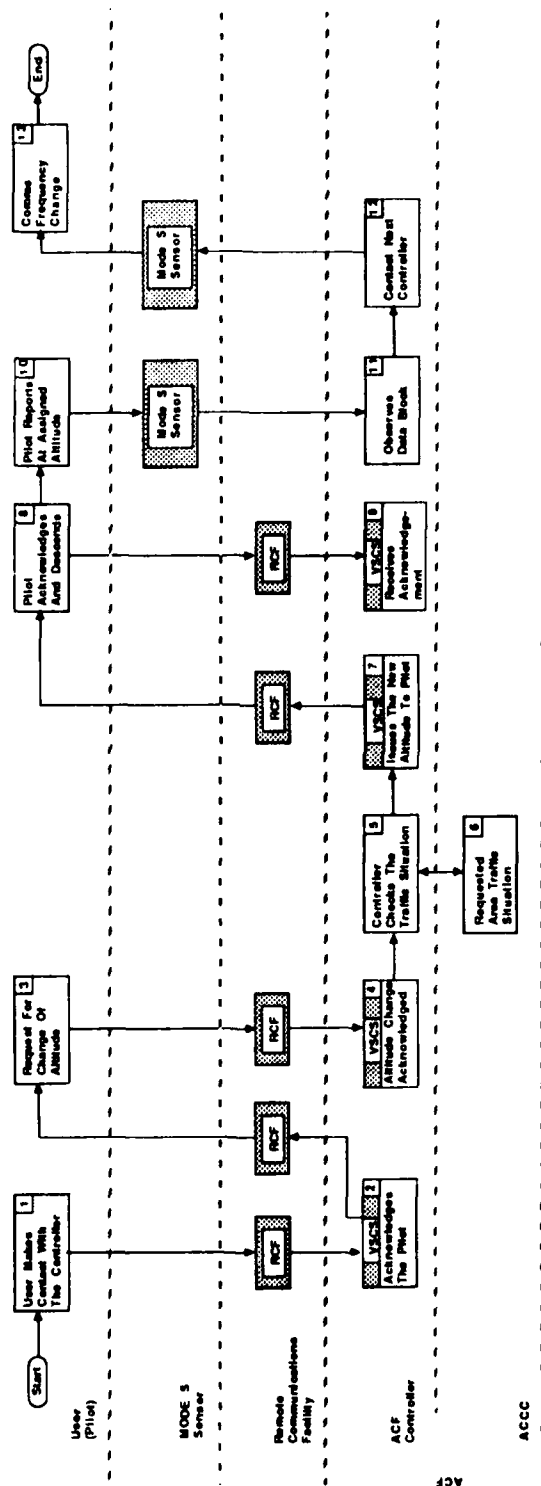**OPERATIONAL SEQUENCE DIAGRAM**

FIGURE 2-7
ACF
AIR-GROUND COMMUNICATIONS (MODE S DATA LINK/VOICE)
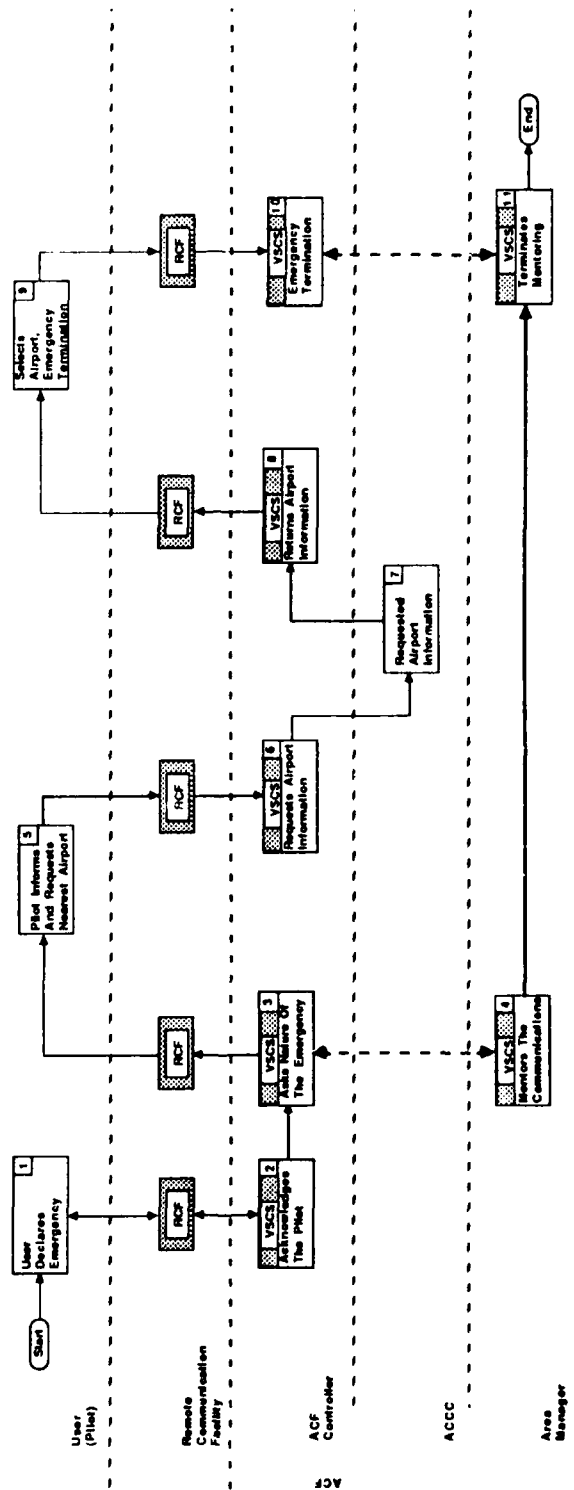OPERATIONAL SEQUENCE DIAGRAM

FIGURE 2-8
ACF
AIR-GROUND COMMUNICATIONS (MONITORING)
OPERATIONAL SEQUENCE DIAGRAM

2-19

The ACF controller acknowledges the call (2) and then asks the pilot the nature of the emergency and his intentions (3). At this time the Area Manager accesses the controllers' position so he can monitor the conversation (4). The pilot requests information from the controller on the nearest airfield (5). The controller, unaware of being monitored, obtains the requested information (6) from the ACCC (7) and transmits it to the pilot (8). The pilot acknowledges the airport information, selects a local airport that is in sight, and terminates the emergency (9). The ACF controller acknowledges the emergency termination (10). The Area Manager, realizing that the controller will need no assistance, discontinues monitoring without having distracted or diverted the controller's attention (12).

2.5.4 ACF Air-Ground Communications Sequence (Data Link)

Figure 2-9 depicts the direct interface between a pilot and the processors without talking directly with a specialist. In this case a pilot requests current weather information and NOTAMs for his route of flight. Through his data link avionics connected to the Mode S transponder, the pilot sends a message (1) requesting the information which is received by the Mode S sensor (2) on the ground. The message request is passed on to the DLP (3) which calls up the applicable weather and NOTAMs for the pilot's route of flight (4). The DLP (5) sends the information back to the Mode S sensor (6) which then transmits the information back to the pilot (7).

2.5.5 ATCT Air-Ground Communications Sequence (Voice)

Figure 2-10 describes the communications between the controller in the Air Traffic Control Tower (ATCT) and the pilot. In this sequence, the pilot approaching his destination airport obtains the local airport weather, runway in use and type of approach to expect (1) by copying the Automatic Terminal Information Service (ATIS) message (2), either in text form through his data link avionics or by monitoring the local VHF voice broadcast with his radios. The pilot then contacts the Local Controller on his VHF radio to request landing clearance (3). The Local Controller acknowledges the request (4), then checks the traffic situation (5) with the TCCC (6) and issues landing instructions to the arriving aircraft (7). The pilot acknowledges the information (8) and follows the Local Controller's instructions. After landing the pilot is advised to contact the Ground Controller after he turns off the runway (9). The pilot then contacts the Ground Controller (10) who advises him to taxi to the parking ramp (11), which he does (12).

2.6 Operational Scenarios

2.6.1 AFSS Air-Ground Communications Scenario (Voice)

Figure 2-11 presents an operational sequence for an AFSS specialist communicating with a pilot through the ICSS. It is similar to the operational sequence diagrams in Figure 2-6; however, this scenario represents the interactions between operators/users for a specific case.

FIGURE 2-9
ACF
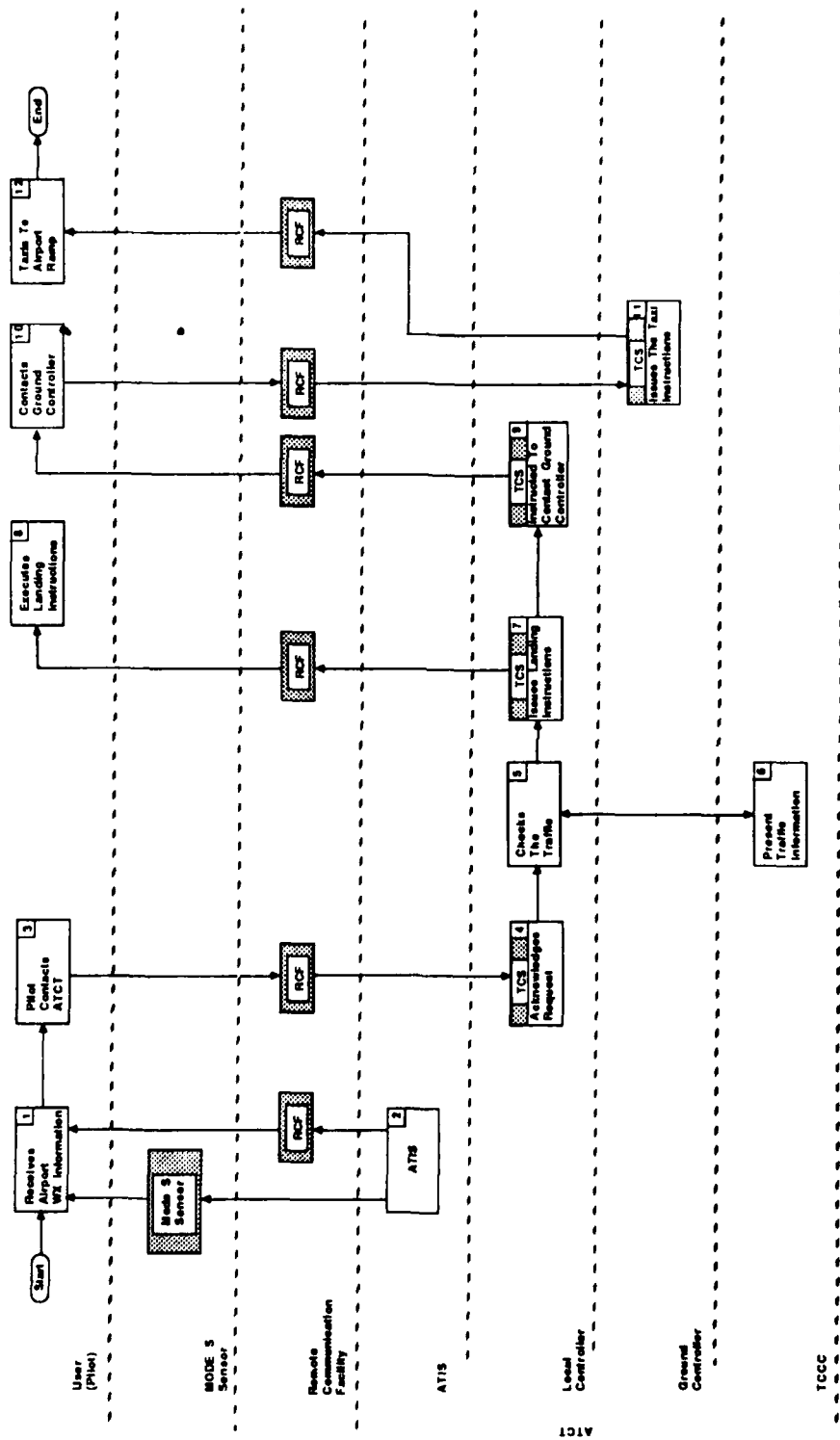AIR-GROUND COMMUNICATIONS (DATA LINK)
OPERATIONAL SEQUENCE DIAGRAM

2-21

FIGURE 2-10
ATCT
AIR-GROUND COMMUNICATIONS (VOICE)
OPERATIONAL SEQUENCE DIAGRAM

2-22

FIGURE 2-11
AFSS
AIR-GROUND COMMUNICATIONS (VOICE)
OPERATIONAL SCENARIO

2-23

In this sequence an En Route Flight Advisory Service (EFAS) specialist
receives a call on his VHF radio from the pilot of N2222MM requesting
inflight weather conditions on his flight from Martinsburg, WV to
Manassas, VA (1). The EFAS specialist queues up the weather conditions
(2) from the FSDPS (3). The EFAS specialist then transmits the weather
data to the pilot of N2222MM via radio (4). Once the pilot receives the
weather briefing via radio (5) and no longer needs the inflight service
he notifies the specialist and changes frequency (6), which the
specialist acknowledges (7).

2.6.2 ACF Air-Ground Communications Scenario (Mode S Data Link/Voice)

In the second scenario Figure 2-12 presents an operational scenario
for an aircraft in contact with an ACF controller. It is similar to the
operational sequence diagrams in Figure 2-7; however, this scenario
shows more detail and represents the interactions between operators/
users for a specific case. In this scenario the use of both data link
and voice are used to demonstrate the interaction of the two methods of
communication.

Once handed-off from an adjacent sector, the pilot of N2025M is
advised via data link to contact the next sector of the Washington ACF.
The pilot makes initial contact with the next controller via voice
channel, alerting him that he is on the assigned frequency (1). The ACF
controller confirms from the aircraft data block that he is in control
of N2025M, acknowledges this with the pilot via voice, and observes that
the aircraft is level at FL220 (2). The pilot of N2025M starts to pick
up light rime ice and immediately asks the controller for a lower
altitude (3), electing to make his request via voice due to the urgent
nature of the situation. The ACF controller acknowledges the altitude
request via voice (4) and checks for a lower altitude with reference to
the traffic within his sector through the ACCC (5). As soon as it is
available the ACF controller enters a new altitude assignment of FL180
into the sector suite and transmits the altitude assignment via voice to
the pilot of N2025M (6). The pilot acknowledges the altitude change via
data link (7) and starts his descent. The ACF controller monitors the
aircrafts descent via the aircraft's data block (8), and confirms the
pilot's new altitude (9) via the data link as viewed on the aircraft
data block (10). When N2025M approaches the boundary of the next sector
(11), the ACF controller completes an automatic hand-off to the next
sector and instructs N2025M by data link to contact the next controller
on a designated frequency (12). The pilot acknowledges the data link
message (13) which results in both data link and voice communications
control being transferred to the next controller and contacts the next
controller.

2.6.3 ACF Air-Ground Communications Scenario (Monitoring)

The third scenario, Figure 2-13, is similar to Figure 2-8 in that
it depicts an emergency situation in more detail. In this scenario an
Area Manager, needing more information to coordinate rescue operations,
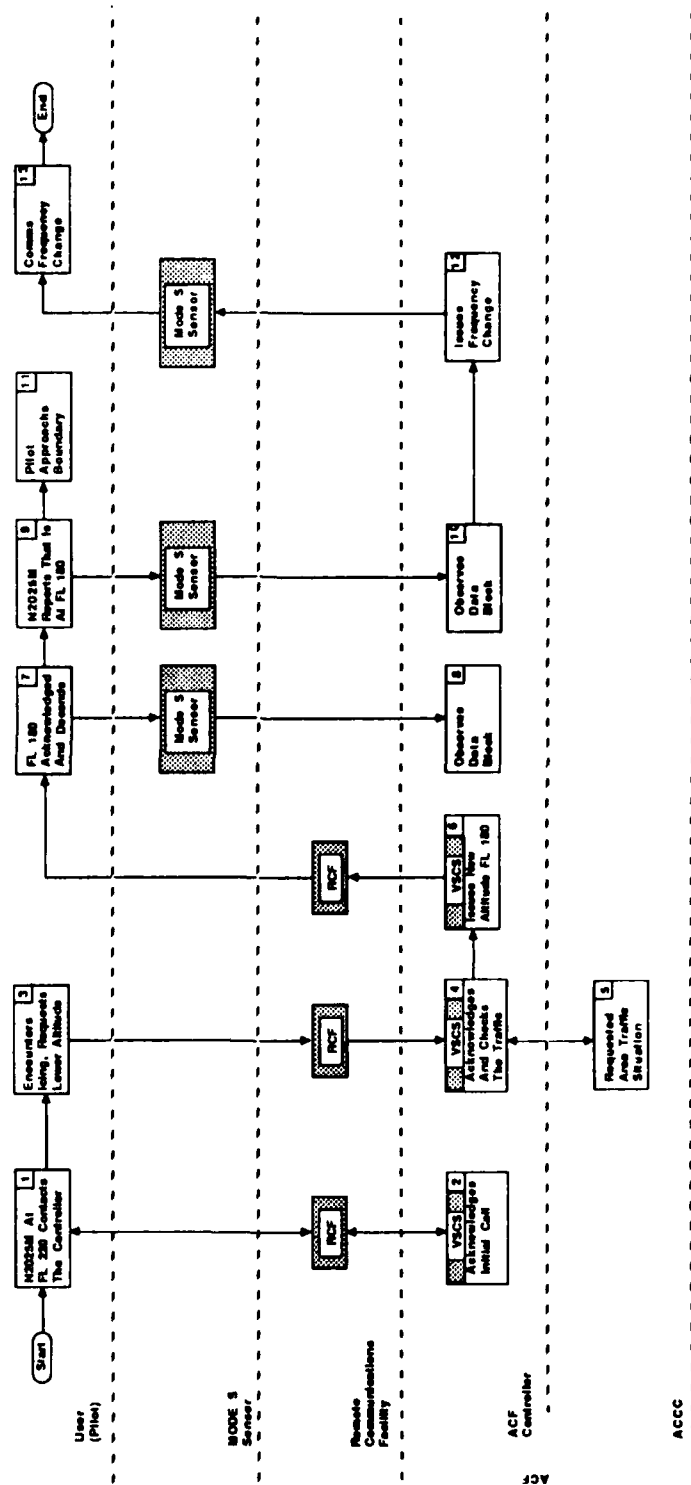monitors the Approach/Departure controller as he works an emergency

FIGURE 2-12
ACF
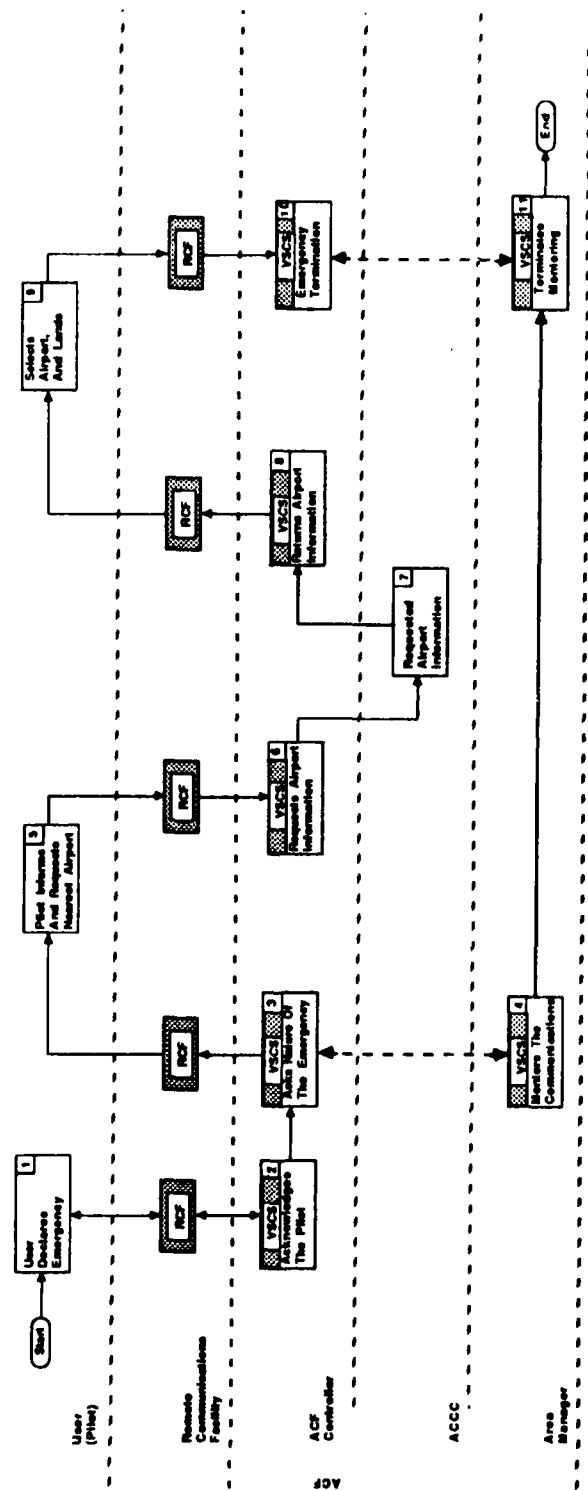AIR-GROUND COMMUNICATIONS (MODE S DATA LINK/VOICE)
OPERATIONAL SCENARIO

FIGURE 2-13
ACF
AIR-GROUND COMMUNICATIONS (MONITORING)
OPERATIONAL SCENARIO

aircraft. This pilot advises the controller that he is having a problem with his left engine (1). The ACF controller receives the call (2) and then asks the pilot for his intentions (3). At this time the Area Manager (4) dials up the controller's position so he can monitor the conversation (4). The pilot requests specific information from the controller on the nearest airfield (5). The controller, still not knowing he is being monitored, obtains the information (6) on the nearest airport from the ACCC (7) and transmits it to the pilot (8). The pilot acknowledges the airport information (9), and upon seeing the closest airport, cancels the emergency. The ACF Controller acknowledges the pilot (10). The Area Manager, realizing that the controller needs no outside assistance, disconnects without the controller detecting any change (11).

2.6.4   ACF Air-Ground Communications Scenario (Data Link)

Figure 2-14 shows a data link weather request from an airborne pilot. It is similar to the operational sequence diagram in Figure 2-9 but shows more detail. In this sequence the pilot of N101CC requests the weather and NOTAMS along his route of flight from White Plains, NY to Wilmington, NC. The pilot makes his request using his data link avionics and Mode S transponder (1). His request is received by the Mode S sensor on the ground (2) which in turn forwards the request to the Data Link Processor (DLP) at the New York ACF (3). The DLP obtains the current weather and NOTAMS for the route of flight from the data base (4). and rou... the information back through the DLP (5). The DLP routes the weat... and NOTAMS to the Mode S sensor nearest to N101CC (6). N101CC receives the requested weather and NOTAMS via his Mode S transponder and data link avionics (7).

2.6.5   ATCT Air-Ground Communications Scenario (Voice)

Figure 2-15 presents an operational sequence for tower controllers communicating with pilots through the TCS. It is similar to the operational sequence diagrams in Figure 2-10; however, this scenario represents the interactions between operators/users for a specific case. This scenario depicts the Local Controller issuing landing clearance to a pilot using the VHF radio frequency.

The pilot of N4327J first obtains the airport and weather information (1) for Hagerstown Airport from the ATIS (2) via data link. The pilot of N4327J then contacts the Hagerstown Tower stating his position and requests landing instructions (3). The Local Controller acknowledges the pilot of N4327J (4), checks the traffic situation (5) with the TCCC (6), and issues landing instructions to the pilot of N4327J (7). The pilot of N4327J acknowledges and executes the landing instructions (8). Upon taxiing clear of the runway, the pilot of N4327J contacts the Ground Controller requesting taxi instructions (9) via radio. The Ground Controller issues taxi instructions to N4327J to taxi to the ramp via radio (10). The pilot of N4327J taxis to the ramp (11).
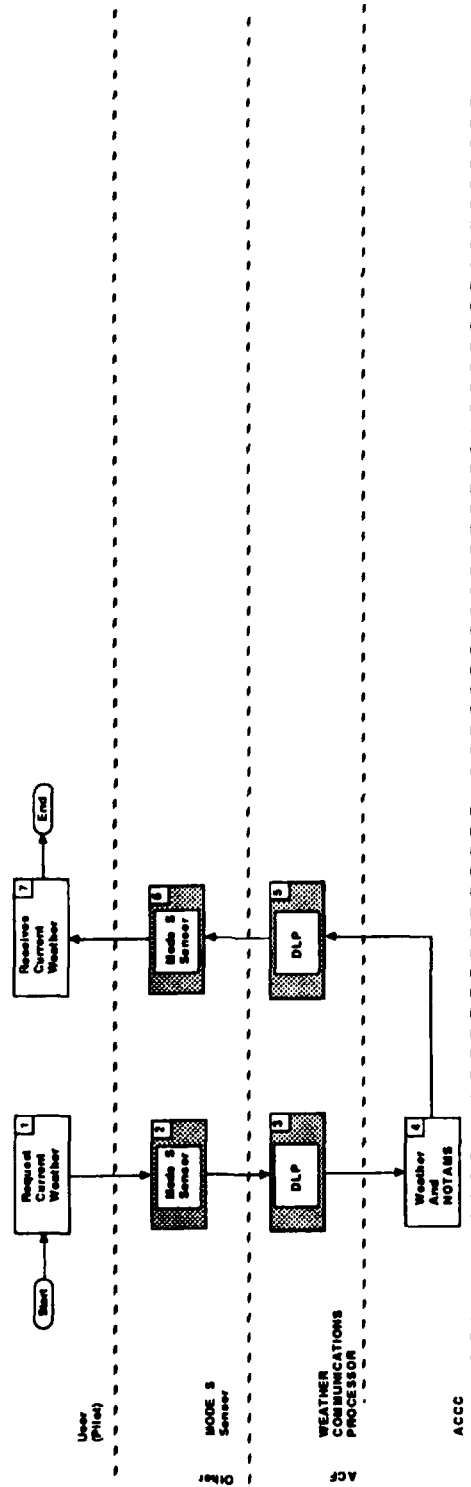
FIGURE 2-14
ACF
AIR-GROUND COMMUNICATIONS (DATA LINK)
OPERATIONAL SCENARIO
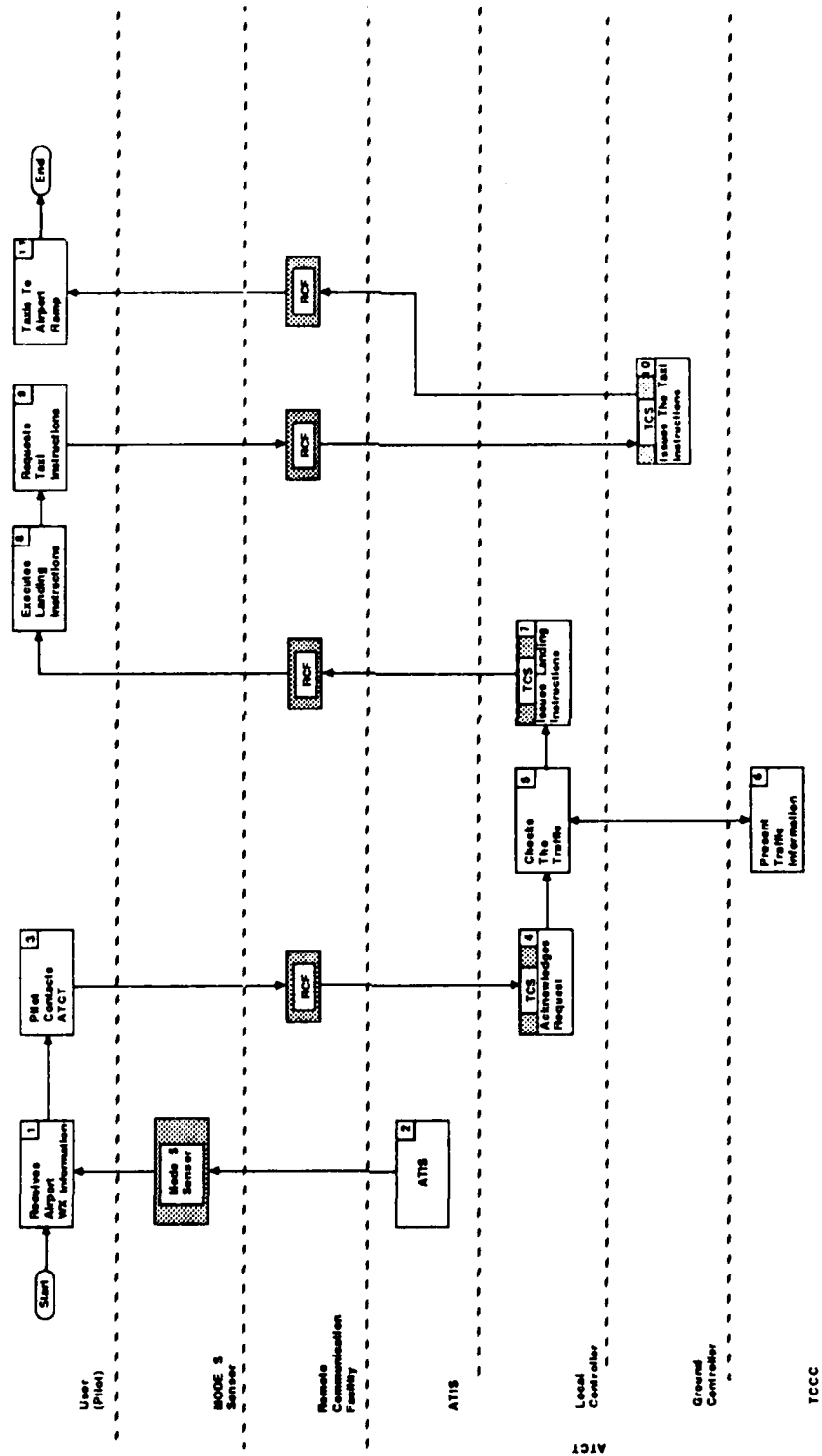
FIGURE 2-15
ATCT
AIR-GROUND COMMUNICATIONS (VOICE)
OPERATIONAL SCENARIO

2-29

REFERENCES

Federal Aviation Administration, <u>Air Traffic Control</u>, FAA Handbook 7110.65F, Current edition, Washington, D.C.

Federal Aviation Administration, <u>Airman's Information Manual</u>, Current edition, Washington, D.C.

Federal Aviation Administration, <u>Flight Service Station Procedures</u>, FAA Handbook 7110.10H, Current edition, Washington, D.C.

Federal Aviation Administration (June 1989), <u>National Airspace System Level I Design Document</u>, NAS-DD-1000B, (Includes SCN-1 through SCN-18), Washington, D.C.

Federal Aviation Administration (September 1989), <u>National Airspace System Plan, Facilities, Equipment and Associated Development</u>, Washington, D.C.

Federal Aviation Administration (April 1989), <u>National Airspace System System Requirements Specification</u>, NAS-SR-1000, (Includes SCN-1 through SCN-8), Washington, D.C.

GLOSSARY

ACF BACKUP - The capability to provide alternate control over the airspace of an ACF that has experienced a catastrophic failure.

ADJACENT FACILITY - A facility whose assigned airspace borders that of the facility being discussed. This applies to an ACF bordering another ACF and to an ATCT bordering an ACF.

ADVISORY - Advice and information provided to assist pilots in the safe conduct of flight and aircraft movement.

AIRCRAFT - Device/s that are used or intended to be used for flight in the air; when used in air traffic control terminology may include the flight crew.

AIR ROUTE TRAFFIC CONTROL CENTER (ARTCC) - A facility established to provide air traffic control service to aircraft principally during the en route phase of flight.

AIR TRAFFIC CONTROL COMMAND CENTER (ATCCC) - An air traffic service facility consisting of Central Flow Control Function (CFCF), Central Altitude Reservation Function (CARF), Airport Reservation Office (ARO), and the ATC Contingency Command Post.

ATCCC SPECIALIST - Traffic management specialist resident at the Air Traffic Control Command Center (ATCCC) who coordinates with local traffic management specialists at ACF's and manages flow control operations.

AREA CONTROL FACILITY (ACF) - A restructured ARTCC which will perform functions both of an ARTCC and a TRACON.

AUTOMATED FLIGHT SERVICE STATION (AFSS) - Air traffic facilities which provide pilot briefing, en route communications, and VFR search and rescue services; assist lost aircraft and aircraft in emergency situations; relay ATC clearances; originate Notices to Airmen; broadcast aviation weather and NAS information; receive and process IFR flight plans; and monitor NAVAIDS. In addition, at selected locations FSSs provide En Route Flight Advisor Service (Flight Watch), take weather observations, issue airport advisories, and advise Customs and Immigration of transborder flights.

CATASTROPHIC FAILURE - The inability of an ACF to perform its operational responsibilities, regardless of cause, as determined by operational authorities.

CLASSIFIED INFORMATION - Official information, including foreign classified information, which has been designated as requiring protection in the interest of national security.

COMMON CONSOLE - Each common console provides identical display and data entry equipment.

EMERGENCY - A safety condition of being threatened by serious and/or imminent danger which requires immediate or timely assistance.

EMERGENCY LOCATOR TRANSMITTER (ELT) - A radio transmitter attached to the aircraft structure which operates from its own power source on 121.5 MHz and 243.0 MHz. It aids in locating downed aircraft by radiating a downward sweeping audio tone, 2-4 times per second. It is designed to function without human action after an accident.

EN ROUTE - One of three phases of flight services (terminal, en route, oceanic). En route service is provided outside of terminal airspace and is exclusive of oceanic control.

EN ROUTE AIR TRAFFIC CONTROL SERVICES - Air traffic control service provided aircraft on IFR flight plans, generally by ARTCCs (ACF), when these aircraft are operating between departure and destination terminal areas. When equipment capabilities and controller workload permit, certain advisory/assistance services may be provided to VFR aircraft.

EN ROUTE FLIGHT ADVISORY SERVICE/FLIGHT WATCH (EFAS) - A service specifically designed to provide, upon request, timely weather information pertinent to the type of flight, intended route of flight, and altitude.

FLIGHT PLAN - Specified information relating to the intended flight of an aircraft that is filed orally or in writing with an ATC facility.

FLOW CONTROL - Measures designed to adjust the flow of traffic into a given airspace, along a given route. or bound for a given airport so as to ensure the most effective utilization of the airspace.

IFR AIRCRAFT/IFR FLIGHT - An aircraft conducting flight in accordance with instrument flight rules.

INTEGRATED COMMUNICATIONS SWITCHING SYSTEM (ICSS) - The ICSS provides voice communications switching systems for new, replaced, or modernized airport control towers (ATCTs), terminal radar approach controls (TRACONs) and automated flight service stations (AFSSs). This system will provide intercom, interphone, and radio communications.

MULTICHANNEL VOICE RECORDERS - Multichannel voice recorders are utilized to record all voice communications between air traffic controllers and pilots. These multichannel recorders are utilized at ATCTs, AFSSs, and ACFs.

NATIONAL RADIO COMMUNICATIONS SYSTEM (NARACS) - Provide the minimum essential command and control communications capability necessary to direct the management, operation, and the constitution of the NAS in

support of FAA/DOT/DOD missions during a national, regional, or local emergency when normal common carrier telecommunications are interrupted.

NATIONAL AIRSPACE SYSTEM (NAS) - The NAS as used herein describes the FAA facilities, hardware, and software that are a predominant part of the NAS infrastructure and the personnel who operate and maintain that equipment to provide services to the user.

NOTICE TO AIRMEN (NOTAM) - A notice containing information (not known sufficiently in advance to publicize by other means) concerning the establishment, condition, or change in any component (facility, service, or procedure of, or hazard in, the National Airspace System) the timely knowledge of which is essential to personnel concerned with flight operations.

OFF-LINE STORAGE - Storage facilities allowing access to information (voice and/or data) recorded within the past 15 days.

ON-LINE STORAGE - Storage facilities allowing immediate access to information (voice and/or data) recorded within the past 24 hours.

REMOTE COMMUNICATIONS AIR/GROUND FACILITY (RCAG) - An unmanned VHF/UHF transmitter/receiver facility which is used to expand ACF air-ground communications coverage and to facilitate direct contact between pilots and controllers.

REMOTE COMMUNICATIONS OUTLET (RCO) AND REMOTE TRANSMITTER/RECEIVER (RTR) - An unmanned communications facility remotely controlled by air traffic personnel. RCOs serve AFSSs; RTRs serve terminal ATC facilities. An RCO or RTR may be UHF or VHF and will extend the communication range of the air traffic facility.

SECTOR SUITE - A sector suite is defined as the collection of data entry and display equipment (i.e., common consoles) that is required at an operational position. An operational position is a Sector Suite adapted to provide automation support for a particular ATC service or function. A sector suite can consist from one to four common consoles. Each common console provides identical display and data entry equipment.Any type of operation position (i.e., Enroute, Radar Approach, Non-Radar Approach , Oceanic, Traffic Management, Area Supervisor, Area Manager, Flight Data Monitor, Trainee, or Simulation Pilot) can be assigned to any common console(s).

SPECIALIST - The internal individual or group who provides service through the NAS (e.g., controllers, engineers, maintenance and management personnel).

TERMINAL AREA - A general term used to describe airspace in which approach control service or airport traffic control service is provided.

TERMINAL AREA FACILITY - A facility providing air traffic control service for arriving and departing IFR, VFR, Special VFR, Special IFR aircraft and, on occasion, en route aircraft.

TOWER/AIRPORT TRAFFIC CONTROL TOWER (ATCT) - A terminal facility that uses air-ground radio communications, visual signaling, and other devices to provide ATC services to aircraft operating in the vicinity of an airport or on the movement area. Authorizes aircraft to land or takeoff at the airport controlled by the tower or to transit the airport traffic area regardless of flight plan or weather conditions (IFR or VFR). A tower may also provide approach control services.

TOWER COMMUNICATIONS SYSTEM (TCS) - Provides a modern voice communications switch and control system for intercom, interphone, and air-ground voice connectivity for ATCTs.

TRAFFIC MANAGEMENT COORDINATOR (TMC) - A traffic management specialist resident at the ARTCC traffic management unit (TMU) providing coordination between the national level central flow control function of the ATCCC and local ARTCC controllers.

TRAFFIC MANAGEMENT SPECIALIST (TMS) - Specialist resident at the air traffic control command center (ATCCC) who coordinates between local traffic management specialists at ARTCCs and manages flow control operations. See ATCCC description.

TRAFFIC MANAGEMENT UNIT (TMU) - A noncontrol, coordination position at an ARTCC connected to the central flow control function at the ATCCC and responsible for dissemination of flow control information at the local level.

USER - The external individual or group that receive services from the NAS (e.g., Pilot, Air Carrier, General Aviation, Military, Law Enforcement Agencies).

VOICE SWITCHING AND CONTROL SYSTEM (VSCS) - Provides a voice communications system which performs the intercom, interphone, and air-ground voice connectivity and control function needed for air traffic control operations in ARTCCs and ACFs.

ACRONYM	MEANING
ACCC	Area Control Computer Complex
ACF	Area Control Facility
AFSS	Automated Flight Service Station
APP/DEP	Approach/Departure
ARINC	Aeronautical Radio Inc.
ATA	Airport Traffic Area
ATC	Air Traffic Control
ATCCC	Air Traffic Control Command Center
ATCT	Air Traffic Control Tower
ATIS	Automatic Terminal Information Service
AWP	Aviation Weather Processor
DF	Direction Finding
D/L	Data Link
DLP	Data Link Processor
EFAS	En Route Flight Advisory Service
ELT	Emergency Locator Transmitter
FSAS	Flight Service Automation System
FSDPS	Flight Service Data Processing System
FSS	Flight Service Station
ICSS	Integrated Communications Switching System
IFR	Instrument Flight Rules
MVR	Multichannel Voice Recorder
MODE S	Discrete Addressable Secondary Radar System With Data Link
NAS	National Airspace System
NASP	National Airspace System Plan
NASSRS	NAS System Requirements Specification
NICS	NAS Interfacility Communications System
NORDO	No Radio
NOTAM	Notice to Airmen
PIREP	Pilot Report
RCAG	Remote Center Air-Ground Communications Facility
RCE	Radio Control Equipment
RCF	Remote Communications Facility
RCO	Remote Communications Outlet
RTR	Remote Transmitter/Receiver
RWP	Real-Time Weather Processor

TCCC	Tower Control Computer Complex
TCS	Tower Communications System
UHF	Ultra High Frequency
UNICOM	Frequencies used for Aeronautical Advisory Services to aircraft
VFR	Visual Flight Rules
VHF	Very High Frequency
VOR	VHF Omnidirectional Range
VSCS	Voice Switching and Control System
WMSC	Weather Message Switching Center
WX	Weather